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TITLE: A Partnership Training Program in Breast Cancer Diagnosis: Concept Development of Next Generation Diagnostic Breast Imaging Using Digital Image Library and Networking Techniques

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13. Abstract ***(Maximum 200 Words)*** *(abstract should contain no proprietary or confidential information)*

This ongoing training program consists of three components, namely: start up, training and research development stages. In the first year of this program, our main effort has been in providing facilities and students with series of lectures in breast imaging, coordination and digitization of mammograms aiming to establish and African-American women mammogram database, and design of a research mammographic workstation.

Under this partnership arrangement, one Ph.D. student is working on separation of benign and malignant masses on mammograms. Five faculty members and four graduate students participated in the lecture series. Five undergraduate students also attended the lecture series and worked with three faculty members to collect cases for the establishment of a breast imaging library and network system at Howard University.

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1. Introduction

This program is a collaboration between participants from Howard University in the Department of Electrical Engineering, the Department of Systems and Computer Sciences, the Department of Radiology and the Cancer Center; and collaborating investigators from Georgetown University Image Science and Information Systems (ISIS). This on-going training program consists of three components, namely: start up, training and research development stages. During the start up stage, the faculty members will be trained in breast cancer imaging. The faculty members will also learn how to develop a unique database, whose patients are primarily African-Americans, that will be available to Howard University and to the investigators involved in breast cancer research and in training the community at large. They will also participate in an internship given by the Radiology Department in an effort to understand the breast cancer screening and diagnosis viewing and related procedure as well as to observe breast cancer patterns on mammograms, ultrasound, and MRI.

Georgetown University investigators and clinical members of the Howard University Hospital have begun to offer a series of lectures including: Breast Anatomy, Physics and Instrumentation of Mammography, Breast Ultrasound, Breast MRI, State-of-the-Art Ultrasound Instrumentation, Cancer Biology and Physiology, Breast Cancer Oncology and Management, and A High-Performance Software Display Workstation for Breast Cancer Research.

Under this partnership arrangement, one Ph.D. student is working on separation of benign and malignant masses on mammograms. One journal paper (led by Dr. S-C. Ben Lo) and two proceeding papers based on this collaboration have been accepted for publication. Five faculty members and four graduate students and participate in the lecture series. Five undergraduate students also attend the lecture series and work with three faculty members to collect cases for the establishment of a breast imaging library and network system at Howard University. Figure 1 shows the organization of this partnership training program.

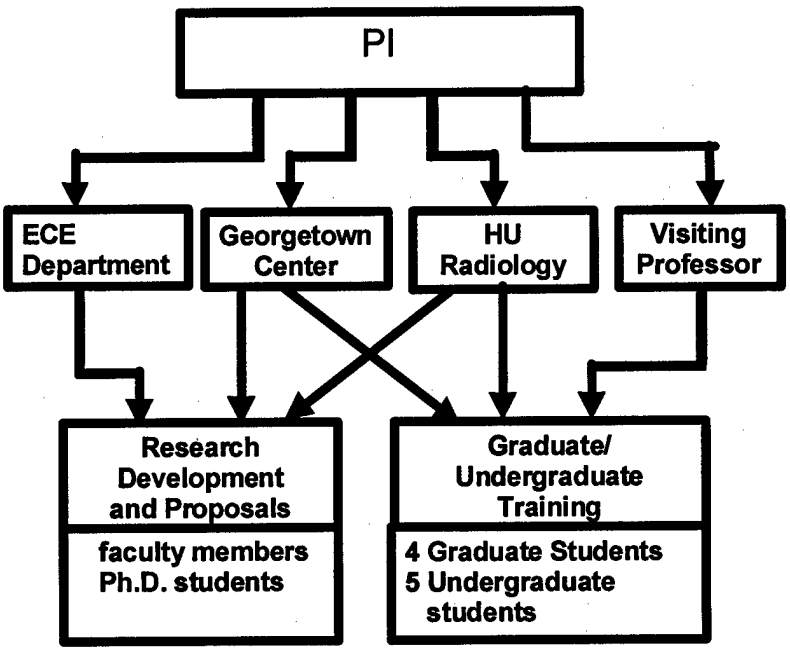

Figure 1. The organization of the partnership training program at Howard University (Department of Electrical Engineering)

2. Training and Research Activities

2.1. Lecture Series (Total 10 lectures were provided to the faculty members and students)

A. A Mammography SoftCopy Display Workstation for Breast Cancer Research - By Dr. Jerry Gaskil (January 15, 2002)

1. Development of display functions mimicking film mammograms on the monitor
2. Mammography workstation design: hardware configuration, display speed, viewing functions, and system evolution
3. System capabilities for adapting functions developed by others (as a training tool)

B. Program plan and Mammography Physics and Image Requirements (part 1) – By Dr. S-C. Ben Lo (January 29, 2002)

1. Introduction of Howard BCRP training program
2. Training program plan
3. Introduction of X-ray physics
4. General X-ray imaging techniques

C. Mammography Physics and Image Requirements (part 2) – By Dr. S-C. Ben Lo (February 12, 2002)

1. Mammography system and its components
2. Mammography physics
3. Screen/film processing
4. Film optical density as functions of exposure, film speed, processing temperature etc.
5. Normal and abnormal structures in mammograms

D. Ultrasound Instrumentation - By Mr. Terry Correll of Philips/ATL (February 22, 2002)

1. Introduction to ultrasound systems
2. State-of-the-art ultrasound mammography: SonoCT, Harmonic Ultrasound
3. Ultrasound system operation
4. 3D ultrasound including transducer design, functions, and operation

E. Cancer Biology and Physiology - By Dr. Theodore Bremner (February 26, 2002)

1. Mammography system and its components
2. Mammography physics
3. Screen/film processing
4. Film optical density as functions of exposure, film speed, processing temperature etc.
5. Normal and abnormal structures in mammograms

F. Genetic Bases of Cancer - By Dr. Theodore Bremner (March 12, 2002)

1. Types of cancer: blood, connective tissue, epithelia tissue
2. Cancer-causing agents (carcinogens)
3. The control of gene expression
4. Proliferation
5. Survival

G. Human Breast Anatomy - By Dr. Matthew T. Freedman (March 26, 2002)

1. Basic anatomy
2. Visualization of the normal anatomy in Mammography
3. The role of breast ultrasound
4. MR breast imaging

H. Physics in Breast Ultrasound - By Dr. S-C. Ben Lo and Ms. Anita Sarcone (April 9, 2002)
1. Principles of diagnostic ultrasound physical characteristics including speed, frequency, and attenuation in different media.
2. Wave propagation phenomena and their implications in medical diagnosis.
3. Description of three modes of ultrasound images (A-, B-, and C- mode)
4. Recent research work at the ISIS center of the Georgetown University Medical Center.

I. Detection and Classification of Breast Cancer – By Ms. Lisa Kinnard (April 16, 2002)
1. Description of segmentation technique, (pixel aggregation combined with maximum likelihood analysis).
2. Description of the Multiple Circular Path Convolution Neural Network (MCPCNN)
3. Comparison between MCPCNN's diagnostic results and Multilayer Perceptron (MLP) neural network's diagnostic results.

J. Nuclear Magnetic Resonance Image - By Dr. Paul C. Wang (April 23, 2002)
1. Explanation of the NMR imaging and spectroscopy diagnostic techniques
2. Illustration of the effects of NMR parameters of the samples such as T1 and T2 relaxation times, spin density and mobility, as well as the imaging parameters
3. Discussion about the potential uses of these techniques and the current research of this fascinating field.

2.2. Digitization of film-based mammograms

Purpose: To educate a group of students on the fundamentals of mammography, how to search for digitized mammograms, and how to digitize films. The ultimate goal of this phase of the Breast Cancer Training Project is to produce a database of digitized mammograms that were obtained from patients who are mostly people of color.

Description of Tasks

The students were responsible for the following tasks during the summer of 2002:

1. Write a report describing mammography
   - Define mammography
   - Describe how mammography works
   - Forms of abnormalities (calcifications vs. masses)
   - Describe malignant and benign image features
   - Describe clinical mammographic procedures
   - Define breast density and its role in breast cancer diagnosis
2. Compile a list of helpful digital mammography tutorial web sites
3. Compile a list of digital mammography database web sites
   - Select the most well organized database and identify items that would prove to be useful to researchers who would like to use the Howard University database (e.g. – ethnicity, shape description of abnormalities, pathology of abnormalities, et cetera)

4. Study various lossless compression methods in an effort to determine the best method for compressing the database images
5. Determine a naming scheme for the digitized images
6. Determine the best method (e.g. – excel spreadsheet) for recording image data (filename, film size, pathology)
7. Digitize mammograms provided by the Howard University Hospital (HUH)

2.3. Workstation Design

Dr. Ahmed Jendoubi is taking the lead to develop a research workstation for mammography. The initial system configuration is shown in Figure 2 and its detailed system components are given below.

Figure 2. An Initial System Configuration

Workstation:

Dell Precision™ Workstation 530
With dual Xeon processor (2GHz, 512K Cache): 2.0GB PC800 ECC RDARM
One nVidia Quadro4 900XGL,128MB VGA/DVI Dual Monitor Capable
Two 73BG Ultra 160/M SCSI,1in (10,000 rpm)
One Internal IOMEGA Zip 250MB
One 20/49X IDE CD-ROM and one 40X/10X/40X CD RW

Monitors:

MultiSync LCD2110 21.3 inch monitor
With XtraView technology to allow viewing images in either orientation
Viewable image size 21.3 inch
Native resolution 1600x1200
Pixel pitch 0.27 mm
Input signal Analog

Software Development:
Use Microsoft C++ with GDI for display of Mammograms.

2.4. Training and Research Activities for the Next Funding Year

1. Development of a mammography workstation for research and clinical viewing
2. Feasibility study for localization of breast lesion in CC and MLO view mammograms
3. Digitization of mammograms to establish a mammography database featuring black women breast images
4. Mini-clinical internship at the radiology department
5. Medical Imaging course
6. Lecture series:
   (1) Image processing course
   (2) How to read mammograms
   (3) Normal and abnormal image patterns and texture features on mammograms
   (4) Paper views:
      (a) Computer-Aided Detection of microcalcifications and masses on mammogram
      (b) Computer-Aided Diagnosis for classification of benign and malignant masses in breast MRI
      (c) Computer-Aided Diagnosis for classification of benign and malignant masses in ultrasound
7. Potential Project Activities
   (1) Characterization of digitized and digital mammograms
   (2) Image processing/enhancement methods for mammograms
   (3) Digital image compression
   (4) Database/Image Library design
   (5) Network study for high-speed communication.

3. Accomplishments

- Provide 10 lecture series in breast imaging and cancer biology (all in graduate level) for the faculty and students at EE Department, Howard University.
- Begin to digitize mammographic film aiming to development a mammography database featuring Africa-American women.
- Begin to design a mammographic workstation.

4. Reportable Outcomes

- Lo S.C.B, Li H., Wang Y., Lisa Kinnard, and Freedman M.T., "A Multiple Circular Path Convolution Neural Network System for Detection of Mammographic Masses," IEEE Trans. on Medical Imaging, vol. 21, No. 2, 2002, pp. 150-158.
- Kinnard L., Lo S-C. B., Wang P., Freedman M.T., Chouikha M, "Separation of Malignant and Benign Masses using a Maximum-Likelihood Analysis and Neural Networks," SPIE Med. Imag. Vol. 4684, 733-741, 2002.
- Chouikha M., Lo S-C. B., Wang P., Jendoubi A., Freedman M.T., Kinnard L., "Development of the Next Generation Breast Cancer Diagnosis Imaging: A Training Program at Howard University", Presented as a poster at the Era of Hope 2002, Orlando Florida, September 25 – September 28, 2002.

Computing Meets the Physical World
National Academy of Engineering

October 8, 2002

Location
National Academies Building
2100 C Street, NW
Washington, DC 20418

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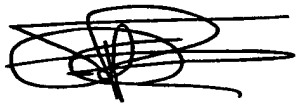

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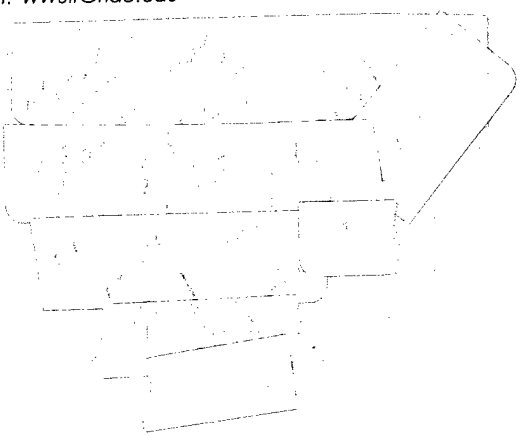

September 12, 2002

Dr. James H. Johnson
Dean
School of Engineering
Howard University
2400 Sixth Street, N.W.
Washington, DC 20059-0001

Dear Dr. Johnson:

Exciting new computing applications from robotic brain surgery to autonomous flying sensors will one day save lives and enable us to do things we never thought possible. On Tuesday, October 8, 2002, the National Academy of Engineering and the National Research Council Computer Science and Telecommunications Board will be holding a one-day symposium to explore the possibilities.

The symposium, "Computing Meets the Physical World," will be held at the National Academies Building, 2101 Constitution Avenue, N.W., Washington, D.C. There is no charge for attending, but registration is required. Enclosed are an agenda and registration form. You may also register online at our website, www.nae.edu.

The deadline for registration is September 27, 2002, but I encourage you to register early. We expect a large turnout and seating is limited. If you will be unable to attend, please pass along news of this event to a friend or colleague. For additional information visit our website at www.nae.edu or contact Nathan Kahl at 202-334-1541 or nkahl@nae.edu.

Sincerely,

Wm. A. Wulf
President

National Academy of Engineering

Computing Meets the Physical World

October 8, 2002
Agenda

8:30 a.m. **Welcome**
Dr. Wm. A. Wulf, President, National Academy of Engineering

Welcome II
Dr. David D. Clark, Chair, Computer Science and Telecommunications Board and Senior Research Scientist, Massachusetts Institute of Technology

Setting the Stage: Why Now, Why Computing?
Dr. Butler Lampson, Distinguished Engineer, Microsoft Corporation

Running with Robots: Soccer and More
Dr. Manuela Veloso, Professor of Computer Science, Carnegie Mellon University

Smart Dust and TinyOS: Hardware and Software for Networked Sensors
Dr. David Culler, Associate Professor and Vice Chair, Computer Science Division, and *Dr. Kristofer Pister*, Professor of Electrical Engineering, University of California at Berkeley

12:30 -2:00 p.m. **Lunch**

2:00 p.m. **Walking with Animals: Bio-Silicon Interfaces**
Dr. Chris Diorio, Assistant Professor, Computer Science Engineering, and *Dr. Thomas Daniel*, Komen Professor of Zoology, University of Washington

Entering the Brain: New Tools for Precision Surgery
Dr. Eric Grimson, Bernard Gordon Professor of Medical Engineering, Massachusetts Institute of Technology and Brigham and Women's Hospital

Closing Remarks
Dr. David D. Clark

4:45-5:30 p.m. **Reception**